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Agricultural Memorandum No. 637

Excess Winter Rainfall in the West of Scotland

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Excess rainfall is a significant factor in the leaching of nutrients and of lime from the soil, and is of importance in land drainage. It has been calculated for each of the twenty years 1954 to 1973 for 44 stations in the main agricultural areas of Scotland, using the method of M.A.F.F. Technical Bulletin No. 24.[1] The material has been divided into three regions. Data for 11 stations in the West of Scotland are given in this paper, the North of Scotland is covered by 17 stations in Agricultural Memorandum No. 635, and the East of Scotland by 16 stations in Agricultural Memorandum No. 636. The division of the material is on the basis of the areas of responsibility of the three Colleges of Agriculture in Scotland.

2. Meteorological records for the twenty-year period were analysed to give estimated soil moisture deficits at monthly intervals. These were the basic data used in the analysis. A few stations with shorter periods of record or non-standard periods were included to improve coverage. The calculation assumes that the first two inches (50 mm) of soil moisture are available for evaporation by the plant cover at the full potential rate, that the next two inches (50 mm) are available at half rate, and that a final one inch (25 mm) can be extracted at quarter rate, i.e. a limit to soil moisture deficit of 5 in. (125 mm). However, in any period with an excess of rainfall over evaporation requirement the soil will be moistened from the top, and the excess will be available for evaporation at the appropriate higher rate. Full details of this type of calculation are given in M.A.F.F. Technical Bulletin No. 16.[2]

3. We define 'Excess Winter Rainfall' as the excess of rainfall over evaporation between the date of return of the soil to field capacity and the end of March. There is however a wide variation in date of return to field capacity from year to year and from place to place. At the one extreme in an exceptionally dry year a deficit of soil moisture may remain throughout an entire winter, with zero excess winter rainfall. This occurred in one or two years in twenty in the low rainfall areas of the East of Scotland and around the Moray Firth, but not in the West of Scotland. At the other extreme, in high rainfall areas there may be several years in twenty when no soil moisture deficit develops. In this case the excess winter rainfall is assumed to commence in July. 'Excess Spring Rainfall' in the three months April to June is examined separately.

4. Excess Winter Rainfall

The mean values of excess winter rainfall (EWR) for the 11 stations are given in Table 1 in order of annual rainfall (R). The relationship between EWR and R is given in millimetres by

$$EWR = 0.81\ R - 370 \qquad (1)$$

with correlation coefficient 0.98. This correlation is between the long-term averages of annual and excess winter rainfall, not of the values for individual years. The annual rainfall for 1916-50 was selected for this comparison because it is widely available for the whole of Scotland.

The mean values of excess winter rainfall range from about 40 per cent of annual rainfall in the coastal region of Ayrshire around Prestwick and Auchincruive, and at West Freugh in Wigtownshire, to 55 per cent of annual rainfall in the high rainfall areas (annual rainfall about 1500 mm).

Table 1 also gives standard deviations, upper and lower quartiles and extremes. The standard deviation (s.d.) of excess winter rainfall is given by

$$s.d. = 0.19\ EWR + 25 \qquad \text{Correlation } 0.94 \qquad \text{(2)}$$

Estimates of excess winter rainfall and standard deviation for any other station can be derived from equations (1) and (2), given only the 1916–50 annual average rainfall. Quartiles and approximate extreme values can be estimated by interpolation in Table 1.

5. Excess Spring Rainfall

Mean values of excess spring rainfall (ESR) are given in Table 2, also the maximum values and the number of years (N) in twenty in which ESR occurs. ESR is given with adequate accuracy for any other station by

$$ESR = 0.11\ R - 95 \qquad \text{Correlation } 0.86 \qquad \text{(3)}$$

6. Comments or suggestions regarding this paper would be welcomed by the author.

Reference

1. "The Significance of Winter Rainfall over Farmland in England and Wales", Technical Bulletin 24, Ministry of Agriculture, Fisheries and Food, 1971.

2. "Potential Transpiration", Technical Bulletin 16, Ministry of Agriculture, Fisheries and Food, 1967.

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Table 1. Excess Winter Rainfall (EWR)

Station (a)	Height m	Period (b)	EWR Mean mm	s.d. mm (c)	Quartiles mm		Extremes mm		R mm (a)
Prestwick	16		355	110	275	435	150	545	935
Auchincruive	45		415	115	350	480	225	695	1000
West Freugh	15		420	100	365	480	225	650	1015
Stirling	46	43–50, 62–73	485	105	410	585	300	710	1025
Abbotsinch	5		475	120	370	570	295	770	1035
Dumfries	49		540	125	445	600	305	855	1085
Machrihanish	10	60–73	515	100	440	590	340	685	1095
Castle Douglas	60		625	145	520	725	350	1015	1170
Rothesay	43		750	155	605	855	510	1055	1425
Helensburgh	96		805	175	690	975	550	1100	1465
Eskdalemuir	242		920	215	755	1050	535	1445	1580

(a) Stations listed in order of R (Annual average rainfall 1916–50)

(b) Period of records used if differing from 1954–73

(c) Standard deviation of EWR

Table 2. Excess Spring Rainfall (ESR)

Station (a)	Grid ref	Height m	R mm (a)	ESR Mean mm	ESR Max mm	N (b)
Prestwick	NS 3626	16	935	8	87	8
Auchincruive	NS 3924	45	1000	8	75	6
West Freugh	NX 1155	15	1015	17	86	11
Stirling	NS 7994	46	1025	27	192	14
Abbotsinch	NS 4867	5	1035	17	67	13
Dumfries	NX 9875	49	1085	36	120	16
Machrihanish	NR 6623	10	1095	27	112	(16)
Castle Douglas	NX 7963	60	1170	44	185	16
Rothesay	NS 0865	43	1425	50	145	17
Helensburgh	NS 3084	96	1465	40	148	19
Eskdalemuir	NT 2303	242	1580	107	306	20

(a) Stations listed in order of R (Annual average rainfall 1916–50)

(b) Number of years in 20 with an excess of spring rainfall. The number given in brackets is from a period shorter than 20 years scaled up to a 20-year value.

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